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Framework and Guidelines for Implementing the Proposed IUCN Environmental Impact Classification for Alien Taxa (EICAT)

Charlotte L. Hawkins[1], Sven Bacher[2], Franz Essl[3], Philip E. Hulme[4], Jonathan M. Jeschke[5,6], Ingolf Kühn[7,8], Sabrina Kumschick[9, 10], Wolfgang Nentwig[11], Jan Pergl[12], Petr Pyšek[12,13], Wolfgang Rabitsch[14], David M. Richardson[9], Montserrat Vilà[15], John R.U. Wilson[9,10], Piero Genovesi[16] & Tim M. Blackburn[1,17,18]

Affiliations:

[1]Department of Genetics, Evolution & Environment, Centre for Biodiversity & Environment Research, Darwin Building, UCL, Gower Street, London WC1E 6BT, UK

[2]Department of Biology, Unit Ecology & Evolution, University of Fribourg, Chemin du Musée 10, 1700 Fribourg, Switzerland

[3]Division of Conservation Biology, Vegetation and Landscape Ecology, University of Vienna, Rennweg 14, 1030 Vienna, Austria

[4]The Bio-Protection Research Centre, PO Box 84, Lincoln University, Christchurch, New Zealand

[5]Leibniz-Institute of Freshwater Ecology and Inland Fisheries (IGB), Müggelseedamm 310, 12587 Berlin, Germany

[6]Freie Universität Berlin, Department of Biology, Chemistry, Pharmacy, Institute of Biology, Königin-Luise-Str. 1-3, 14195 Berlin, Germany

[7]UFZ, Helmholtz Centre for Environmental Research, Department of Community Ecology, Theodor-Lieser-Str. 4, 06120 Halle, Germany

[8]German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Deutscher Platz 5e, 04103 Leipzig, Germany

[9]Centre for Invasion Biology, Department of Botany and Zoology, Stellenbosch University, Private Bag X1, Matieland 7602, South Africa

[10]South African National Biodiversity Institute, Kirstenbosch National Botanical Gardens, Claremont 7735, South Africa

[11]Institute of Ecology and Evolution, University of Bern, Baltzerstrasse 6, CH-3012 Bern, Switzerland

[12]Institute of Botany, Department of Invasion Ecology, The Czech Academy of Sciences, CZ-252 43 Průhonice, Czech Republic
[13]Department of Ecology, Faculty of Science, Charles University in Prague, Viničná 7, CZ-128 44 Praha 2, Czech Republic
[14]Environment Agency Austria, Department of Biodiversity and Nature Conservation, Spittelauer Lände 5, 1090 Vienna, Austria
[15]Estación Biológica de Doñana (EBD-CSIC), Avda. Américo Vespucio, s/n, Isla de la Cartuja, 41092 Sevilla, Spain
[16]ISPRA, Institute for Environmental Protection and Research and Chair IUCN SSC Invasive Species Specialist Group, Via Vitaliano Brancati 48, 00144 Rome, Italy
[17]Distinguished Scientist Fellowship Program, King Saud University, Riyadh 1145, Saudi Arabia
[18]Environment Institute, School of Earth & Environmental Sciences, University of Adelaide, Adelaide, South Australia, 5005 Australia

1. Introduction

Human activities are transforming natural environments by moving taxa beyond the limits of their native geographic ranges into areas in which they do not naturally occur. Many of these alien taxa have caused substantial changes to the recipient ecosystems. For example, alien taxa have been shown to cause significant changes in native species extinction probabilities, genetic composition of native populations, behaviour patterns, species richness and abundance, phylogenetic and taxonomic diversity, trophic networks, ecosystem productivity, nutrient cycling, hydrology, habitat structure, and various components of disturbance regimes [1-8]. For these reasons, most scientists and conservation organisations consider many alien species to be undesirable additions to ecosystems, and frequently devote considerable resources towards preventing or mitigating their impacts. Recognising that impacts vary greatly among taxa and among recipient ecosystems, habitats or native species in the recipient geographic range, and that many notable impacts only become obvious or significantly influential long after the onset of invasion, there is a critical need for the capacity to evaluate, compare, and predict the magnitudes of the impacts of different alien taxa, in order to determine and prioritise appropriate actions where necessary.

A unified classification of alien species based on the magnitude of their environmental impacts [9] (hereafter referred to as the Environmental Impact Classification for Alien Taxa, abbreviated to EICAT) has been developed in response to these issues, as a simple, objective and transparent method for classifying alien taxa in terms of the magnitude of their detrimental environmental impacts in recipient areas. Alien taxa are classified into one of five 'impact' categories depending on the level of biological organisation (individual, population or community) impacted, with the mechanisms by which the impacts occur aligned with those identified in the International Union for Conservation of Nature (IUCN) Global Invasive Species Database ([GISD]; http://www.issg.org/database/welcome). The EICAT adopts parallel classification systems to capture both the maximum impact ever recorded and the current impact level caused by the alien taxon. This ensures that the EICAT captures the maximum recorded impact of an alien taxon introduced to a new area, as well as indicating any change in current environmental impact through successive assessments. The EICAT therefore can (i) identify those taxa that have different levels of environmental impact, (ii) facilitate comparisons of the level of impact by alien taxa among regions and taxonomic groups, (iii) facilitate predictions of potential future impacts of taxa in the target region and elsewhere; (iv) aid in prioritisation of management actions, and (v) aid in evaluation of management methods. It is envisaged that the EICAT scheme will be used by scientists, land managers and conservation practitioners as a tool to gain a better understanding of the magnitude of impacts caused by different alien taxa, to alert relevant stakeholders to the possible consequences of the arrival of certain alien species, and to inform the prioritisation, implementation and evaluation of management policies and actions.

It must be stressed at the outset that EICAT scheme is not a risk assessment, and its output alone should not be used to assign the priority that should be attached to the control or management of any given alien species. Risk assessment and priority setting require contextual information that is not incorporated into the EICAT scheme. The output of the EICAT scheme is also not a statutory list of harmful invasive species. Thus, while it may be useful for ranking and prioritisation of management activities for established alien species within a country, the EICAT scheme should not be used alone to identify which alien species should be regulated. Furthermore, any decision that could have effects on the regulation of trade of species must comply with existing international agreements, including the Convention on Biological Diversity and its guidance on invasive alien species, WTO Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement), and the Convention on International Trade in Endangered Species of Wild Fauna and Flora, amongst others. Under the SPS Agreement and the Guidance on Devising and Implementing Measures to Address the Risks Associated with Introduction of Alien Species as Pets, Aquarium and Terrarium Species, and as Live Bait and Live Food adopted under the Convention on Biological Diversity (COP 12[1]), States are allowed to take appropriate measures to reduce the risks associated with importation or movement of alien species beyond their biogeographic boundaries based on an appropriate risk assessment. The EICAT system has the potential to inform statutes adhering to the relevant international agreements above, to support the implementation of appropriate measures, and to inform risk assessments, but it does not replace them.

To derive maximum benefit from the EICAT system, the system must be applied in a consistent and comparable manner across different assessments. Therefore, here we present a standardised protocol to be applied to this assessment, that is analogous to, and draws heavily upon, the framework adopted for classifications for the globally recognised IUCN Red List of Threatened Species [10]. The document that follows describes the proposed system and provides a framework and detailed guidelines for the assessment process, the documentation required to support assessments, and how to deal with uncertainty in the process.

2. Abbreviations

CG – Cryptogenic

DD – Data Deficient

GISD – Global Invasive Species Database

ISSG – Invasive Species Specialist Group

IUCN – International Union for Conservation of Nature

MV – Massive

[1] http://www.cbd.int/doc/meetings/cop/cop-12/insession/cop-12-L-05-en.pdf

MC – Minimal Concern

MN – Minor

MO – Moderate

MR – Major

NA – No Alien Population

NE – Not Evaluated

3. Definitions

Alien taxon

A species, subspecies or (for plants) variety or cultivar, moved by human activities beyond the limits of its native geographic range or resulting from breeding or hybridization and being released into an area in which it does not naturally occur. The movement allows the taxon to overcome fundamental biogeographic barriers to its natural dispersal. The definition includes any part, gametes, seeds, eggs, or propagules of such species that might survive and subsequently reproduce. Natural dispersal of species either within postglacial habitat expansion or due to climate shift, does not qualify to label a species as alien. Common synonyms include non-native, non-indigenous, foreign, and exotic. The definition is modified from http://www.cbd.int/decision/cop/?id=7197 and [11].

Current Impact

The EICAT category into which a taxon is classified based on the contemporaneous environmental impact caused by the alien taxon to a recipient ecosystem. The Current Impact level may differ from the highest ever recorded impact (Maximum Recorded Impact) for the taxon, for example due to management actions implemented to reduce the impact of alien taxa. Only the highest impact reported is considered for assessment purposes.

Cryptogenic

Cryptogenic taxa are those for which it is unclear, following evaluation, whether the individuals present at a location are native or alien [12]. This is a particular problem in the marine realm, for cosmopolitan plants, for easily spreading species, and for species in biogeographically poorly known taxonomic groups, including many stored product arthropod pests, for which the native geographic ranges are unknown. Cryptogenic taxa may have deleterious impacts where they occur.

Environmental impact

A measurable change to the properties of an ecosystem caused by an alien taxon [2]. This definition applies to all ecosystems—whether largely natural or largely managed by humans—but explicitly considers only effects that have impacts on the native biota or the ecosystem functions that derive from that environment. The same alien taxon may also have impacts on human societies and economies [13], but these are not considered here.

Deleterious impact

An impact that changes the environment in such a way as to reduce native biodiversity or alter ecosystem functions to the detriment of the incumbent native species—as indicated by a change in importance or abundance following invasion [14]. This definition intentionally excludes societal judgments regarding the desirability or value of aliens, although it is assumed here that the classification will be used as a mechanism to prevent impacts that are judged to be ''negative'' by those concerned.

Focal region

A region from which data on the impacts of an alien taxon are used to inform an EICAT assessment. This region will be the region in which the alien taxon is having its maximum recorded environmental impacts (see also section 4.3.2.).

Impact mechanisms

Categories into which different types of impacts are classified. A list of these impact mechanisms is given in section 4.2.

Invasive alien taxon

An alien taxon whose introduction and/or spread threatens biological diversity. This definition follows the Convention on Biological Diversity (http://www.cbd.int/decision/cop/?id=7197). The requirement that an invasive alien taxon cause threat or harm is common in policy usage (see also Executive Order 13112 of the United States Government), but less so in scientific usage where "invasive" usually simply implies that the taxon has spread widely from the point of establishment [11]. The EICAT scheme may be useful for determining which alien taxa are considered to be invasive for the purposes of policy decisions.

Maximum Recorded Impact

The EICAT category into which a taxon is classified based on the highest recorded level of environmental impact caused by the alien taxon to a recipient ecosystem anywhere in the World (or in the geographical area of interest) at any point in time. The Maximum Recorded Impact for the taxon may differ from its Current Impact level, for example due to management actions implemented to reduce the impact of alien taxa, or due to natural variation in the impact level.

Native Community

The assemblage of populations of naturally occurring taxa present in the area invaded by the alien taxon.

Propagule pressure

A composite measure of the number of individuals (of any stage or parts of individuals enabling reproduction) that are released or escape into an area to which they are alien. It incorporates estimates of the absolute number of individuals involved in any one release/escape event (propagule size), the number of discrete such events (propagule number), and the recurrence of such events (propagule frequency) [15].

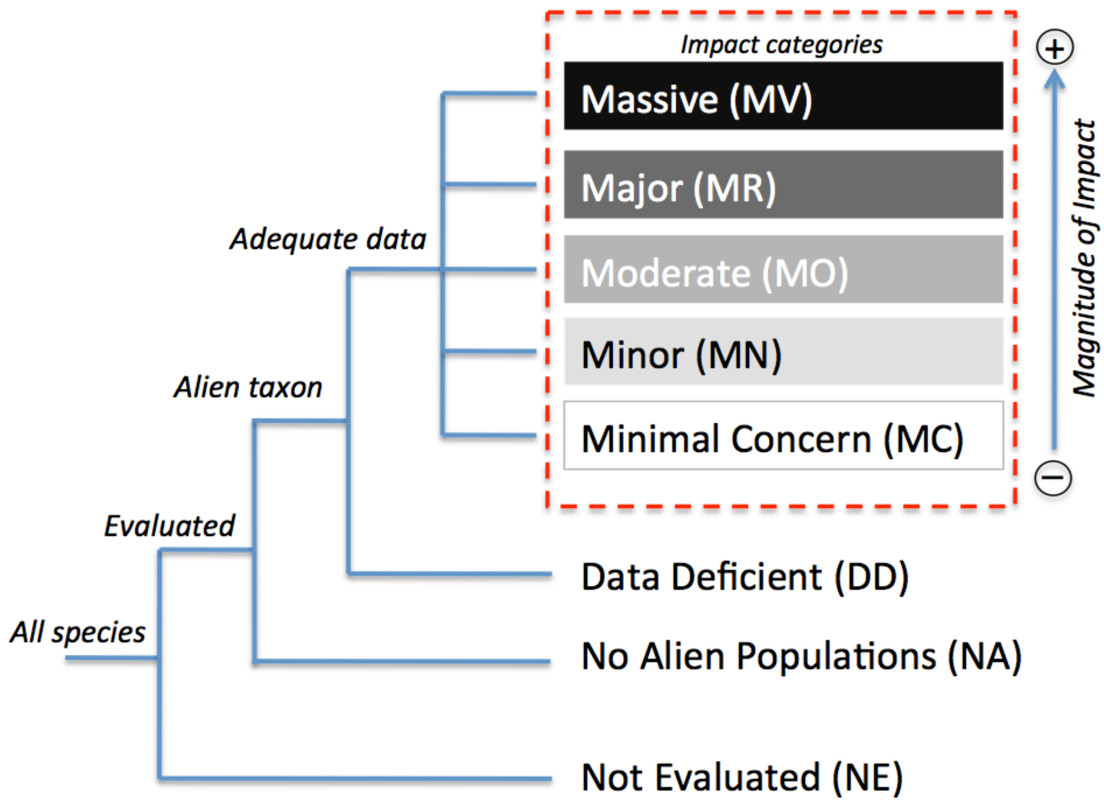

Figure 1. The different impact categories and the relationship between them. Descriptions of the categories are provided in Box 1. The CG category is not represented here as CG taxa may be found in any category.

Residence time

The length of time that an alien taxon has been in a region in which it does not naturally occur [16]. This is often not known, and the term Minimum Residence Time is often used [17].

4. Description of Categories and Criteria

4.1 Impact Categories

There are eight clearly defined categories into which taxa can be classified (Figure 1). Complete definitions of the categories are given in Box 1. The first five categories follow a sequential series of impact scenarios describing increasing levels of impact by alien taxa. These scenarios were designed such that each step change in category reflects an increase in the order of magnitude of the particular impact so that a new level of biological organization is involved (and the associated codes so that they increase alphabetically). Thus: **Minimal Concern (MC) -** discernible impacts, but no effects on individual fitness of native species; **Minor (MN)** – fitness of individuals reduced, but no impact on populations; **Moderate (MO) -** changes to populations, but not to community composition; **Major (MR) -** community changes, which are reversible; and **Massive (MV)** – irreversible community changes and extinctions. Taxa should be classified based on the highest criterion level met across any of the impact mechanisms (Table 1), for two timeframes: their highest impact ever recorded (Maximum Recorded Impact) and their current level of impact (Current Impact). Listing of a taxon in a higher category explicitly assumes that there is evidence that the taxon has had a greater deleterious impact on some aspect of an environment in which it is alien than a taxon in a lower category of impact.

The remaining three categories do not reflect the impact status of a taxon. The **Data Deficient** category highlights taxa for which evidence suggests that alien populations exist, but for which current information is insufficient to assess their level of impact. The category **No Alien Population** is self-explanatory, and should be applied when there is no evidence to suggest the taxon has or had individuals existing in a wild state beyond the boundary of its native geographic range. The category **Not Evaluated** applies to taxa that have not yet been evaluated against the EICAT Categories.

Finally, the label **Cryptogenic (CG)** should be applied to taxa for which it is unclear whether individuals present at a location are native or alien. **CG** is not a category in itself; cryptogenic taxa should be evaluated as if they were aliens, but their impact classification modified by the **CG** label.

Box 1. EICAT Categories

Minimal Concern (MC)

A taxon is considered to have impacts of **Minimal Concern** when it is unlikely to have caused deleterious impacts on the native biota or abiotic environment. Note that all alien taxa have impacts on the recipient environment at some level, for example by altering species diversity or community similarity (e.g. biotic homogenisation), and for this reason there is no category equating to "no impact". Taxa that have been evaluated under the EICAT process but for which impacts have not been assessed in any study should not be classified in this category, but rather should be classified as **Data Deficient**.

Minor (MN)

A taxon is considered to have **Minor** impacts when it causes reductions in the fitness of individuals in the native biota, but no declines in native population sizes, and has no impacts that would cause it to be classified in a higher impact category.

Moderate (MO)

A taxon is considered to have **Moderate** impacts when it causes declines in the population size of native species, but no changes to the structure of communities or to the abiotic or biotic composition of ecosystems, and has no impacts that would cause it to be classified in a higher impact category.

Major (MR)

A taxon is considered to have **Major** impacts when it causes the local or population extinction of at least one native species, and leads to reversible changes in the structure of communities and the abiotic or biotic composition of ecosystems, and has no impacts that cause it to be classified in the **MV** impact category.

Massive (MV)

A taxon is considered to have **Massive** impacts when it leads to the replacement and local extinction of native species, and produces irreversible changes in the structure of communities and the abiotic or biotic composition of ecosystems. Note that ''local'' refers to the typical spatial extent over which the original native communities can be characterised.

Data Deficient (DD)

A taxon is categorised as **Data Deficient** when the best available evidence indicates that it has individuals existing in a wild state in a region beyond the boundary of its native geographic range, but either there is inadequate information to classify the taxon with respect to its impact, or insufficient time has elapsed since introduction for impacts to have become apparent. It is expected that all introduced taxa will have an impact at some level, because by definition an alien individual in a new environment has a nonzero impact. However, listing a taxon as **Data Deficient** recognises that current information is insufficient to assess that level of impact.

No Alien Population (NA)

A taxon is categorised as **No Alien Populations** when there is no reliable evidence that it has or had individuals existing in a wild state in a region beyond the boundary of its native geographic range. We assume that absence of evidence is evidence of absence in this case, as it is impossible to prove that a taxon has no alien individuals anywhere in the world. Taxa with individuals kept in captivity or cultivation in an area to which it is not native would be classified here. A taxon could currently have no individuals existing in a wild state in a region beyond the boundary of its native geographic range because it has died out in, or has been eradicated from, such an area. In these cases, there should be evidence relating to impact that causes it to be classified in one of the impact categories (**MC**, **MN**, **MO**, **MR**, **MV**), or alternatively no evidence of impact, which would cause it to be classified as **Data Deficient**.

Not Evaluated (NE)

A taxon is **Not Evaluated** when it has not yet been evaluated against the EICAT categories and criteria, as is also the case in the IUCN Red List [10].

Cryptogenic (CG)

Cryptogenic is not a category within the scheme presented in Figure 1, but rather a label to be applied to those taxa for which it is unclear, following evaluation, whether the individuals present at a location are native or alien [12]. This is a particular problem in the marine realm, for cosmopolitan plants and for many stored product arthropod pests, for which the native geographic ranges are unknown. Cryptogenic taxa may have deleterious impacts where they occur. We suggest on the basis of the precautionary principle that cryptogenic taxa are evaluated as if they were aliens, but that their impact classification is modified by the **CG** label (e.g., for a cryptogenic species with **Major** impact: *Genus species* **MR** [**CG**]).

4.1.1 Guidelines for applying categories

Impacts are classified based on the level of biological organization affected (individuals → populations → communities (reversible) → communities (irreversible)) (Figure 2), with the impact category determined from the highest level of organization affected under any of the impact mechanisms listed in section 4.2. To meet the need for a system which can both indicate the highest probable impact of an alien taxon, and report on its current level of impact, the EICAT uses a dual classification system. On first assessment, the evidence should be evaluated and taxa should be assessed for both their **Maximum Recorded Impact** (i.e. the highest level of impact ever documented for the taxa), and their **Current Impact** (i.e. the current highest level of impact documented for the taxa), caused under any of the impact mechanisms in section 4.2. The Maximum Recorded Impact and Current Impact may differ if, for example, a management plan has been implemented to control an alien taxon and reduce its impacts in the native environment, or due to natural variation in impact level. In this case it is expected that the Maximum Recorded Impact category will be higher than the Current Impact category.

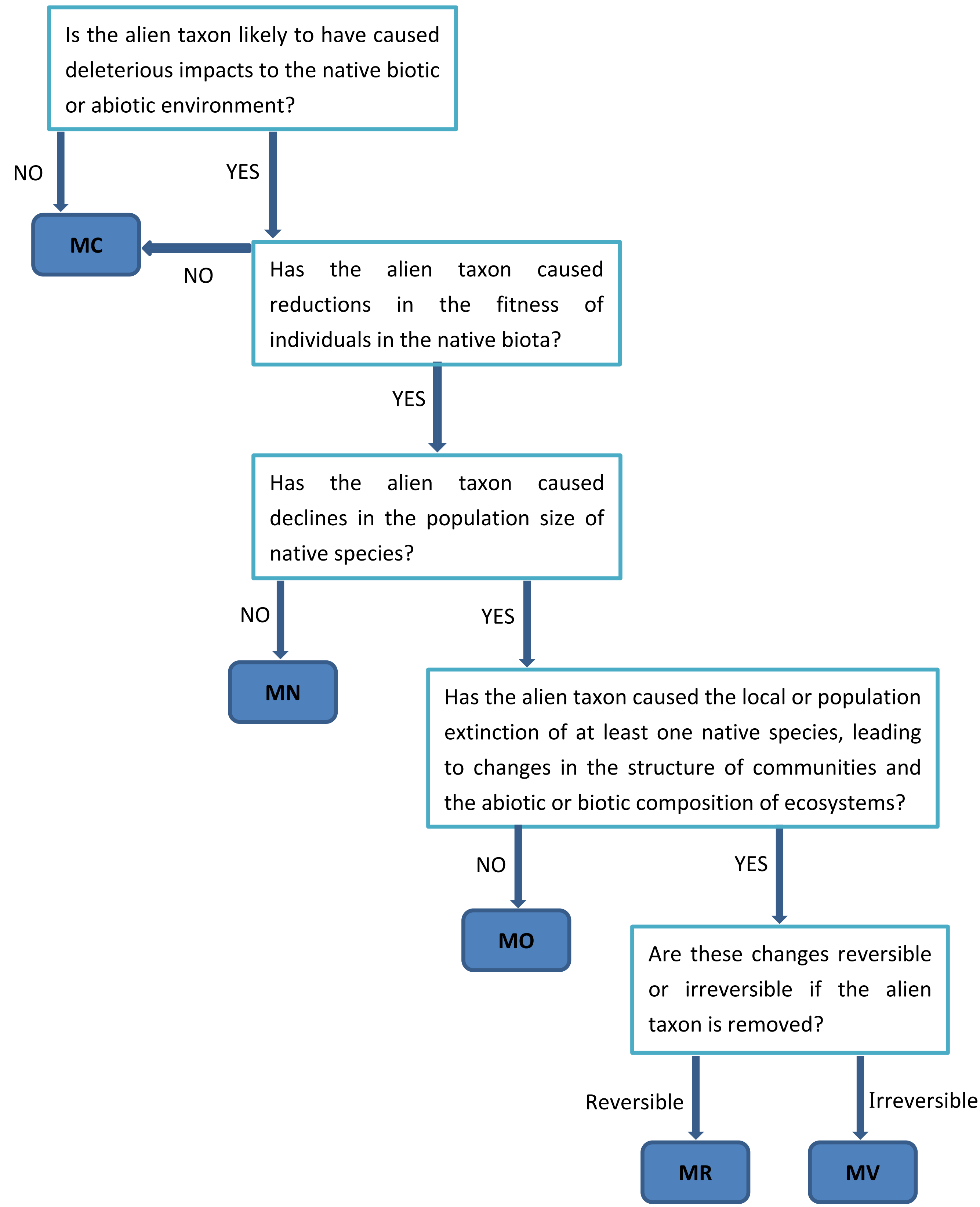

Figure 2. A decision chart showing how the EICAT categories should be applied

In many cases, it is difficult to distinguish whether an alien taxon is the driver of environmental changes, or simply a ''passenger'' responding to the same driver as the natives [18]. Moreover, synergistic interactions between alien taxa and other stressors are also possible—and perhaps increasingly common—but difficult to anticipate [19]. The EICAT scheme takes a precautionary approach: when the main driver of change is unclear, it should be assumed to be the alien taxon for the purposes of the EICAT process. However, the system is intended to be dynamic, allowing for updates as new or more reliable data become available, and as the documented impact history of a taxon unfolds across space and time.

The following terms, used to describe changes at different levels of biological organization, should be clearly understood in the context of the EICAT categories and criteria, to ensure taxa are assessed correctly.

Reduction in fitness of individuals

A reduction in fitness may be evidenced as a reduction in growth, reproduction, defence, immunocompetence, or any other aspect that may reduce the ability of native individuals to survive and produce successful offspring, which has occurred as a result of the introduction of the alien taxa.

Decline in population size

Here, 'population' refers to a group of individuals of a native species within the alien range of the taxon being assessed. We have adopted the same definition of population size as used in the IUCN Red List, and thus we define population size as **the total number of mature individuals** of the native species in the area invaded by the alien taxon.

A decline in population size is a **reduction in the number of mature individuals of native species** that has happened as a result of the introduction of the alien taxon. The downward phase of a fluctuation in a normally fluctuating population will not count as a reduction.

We note that in cases where an alien taxon impacts on recruitment in native species, the above definition of population size means that this impact will not count as a reduction in population size unless there is also an impact on the number of mature individuals, and therefore will be classified as **MN** due to causing a reduction in fitness of native individuals. If and when this decrease in fitness leads to a decrease in the resultant number of mature individuals within the native population, the alien taxon will be reclassified as **MO** (see Box 1 for category definitions).

Notes on defining 'Mature Individuals'

The number of mature individuals is the number of individuals known, estimated or inferred to be capable of reproduction. When estimating this quantity the following points should be borne in mind:

- Mature individuals that will never produce new recruits should not be counted (e.g., densities are too low for fertilization).
- In the case of populations with biased adult or breeding sex ratios, it is appropriate to use lower estimates for the number of mature individuals, which take this into account.
- Where the population size fluctuates, use a lower estimate. In most cases this will be much less than the mean.
- Reproducing units within a clone should be counted as individuals, except where such units are unable to survive alone (e.g., corals).
- In the case of taxa that naturally lose all or a subset of mature breeding individuals at some point in their life cycle, the estimate should be made at the appropriate time, when mature individuals are available for breeding.

Local or population extinction

Local or population extinction refers to the elimination of one or more native taxa since the arrival of the alien taxon, in part or all of the area invaded by the alien taxon. A native taxon is presumed locally extinct when there is robust evidence from known and/or expected habitat within the local area invaded by the alien taxon that no individuals of the native taxon remain. Local or population extinction differs from global (species) extinction as the former refers to elimination from a particular area, whereas the latter refers to the complete global elimination of a species from all parts of its range. In situations where a species is only known from one locality, or only a single population exists, local or population extinction may also result in the species' global extinction. This may occur on islands for example, if introduction of an alien species leads to the local extinction of an island endemic species.

Changes to community structure

Change to the structure of communities refers to alterations that arise from the local or population extinction of one or more native species since the arrival of the alien taxon. Structural changes that do not engender compositional changes (e.g. to the species-abundance distribution of the community) are not included under this definition, as these are covered by the criterion relating to changes in population size.

Reversible

The term reversible is used in the **Major** (**MR**) category, in the context of 'changes to structure of communities and abiotic or biotic composition of ecosystems'. Here, reversible means that there is evidence that if the alien taxon were removed, the structure of the native community and abiotic/biotic compositions of ecosystems could return to the same state as before the invasion occurred. This evidence may be based on observation, experimental data, or inference. An example of this would be where a locally extinct native species returns (or is returned) to an area after removal of the alien taxon, due to recolonization from populations outside the range of the alien taxa.

Irreversible

The term irreversible is used in the **Massive** (**MV**) category, in the context of changes to structure of communities and abiotic or biotic composition of ecosystems. Here, irreversible means that there is evidence that removal of the alien would not result in the native community and abiotic/biotic composition of the ecosystem returning to the pre-invasion state. The clearest example of an irreversible change is the global extinction of a taxon, but other possible irreversible changes include a regime shift (i.e. altered states of ecosystem structure and function that are difficult or impossible to reverse), or an impact that means that native species cannot return (or be returned) to the invaded area. Irreversible may also be "irreversible in practice", i.e. the effort or cost required to reverse the situation is so great, or beyond current technological capabilities, that it would not happen, even if in theory it might be possible.

4.1.2 Transfer between categories

Classification is based on the best available current evidence. Hence, in successive assessments, taxa can move up and down impact categories as the quality of evidence improves, as conditions change, or as an invasion proceeds. At the most trivial level, we would expect taxa to move, in successive assessments, from Not Evaluated (**NE**) into one of the evaluated categories (Figure 1), but subsequently from No Alien Population (**NA**) to an alien category (Data Deficient (**DD**)**,** or one of Minimal Concern (**MC**), Minor (**MN**), Moderate (**MO**), Major (**MR**), or Massive (**MV**)) if introduced into areas beyond natural range limits. Changes to the impact category (**MC**, **MN**, **MO**, **MR**, **MV**) describing Current Impact are then foreseeable in successive assessments. The rules governing transfer between categories differ between the Maximum Recorded Impact and the Current Impact classifications, as described below.

4.1.2.1 Maximum Recorded Impact

The Maximum Recorded Impact category for evaluated alien taxa should remain the same throughout successive assessments <u>unless</u> new evidence suggests that the Maximum Recorded Impact for a particular taxon is higher or lower than previously assessed. For example, if new evidence suggests that the alien taxon is a passenger rather than a driver of change, the Maximum Recorded Impact classification may be reduced to a lower category. Similarly, if new evidence suggests that the taxon has greater impacts than previously known, which cross the threshold for the next impact category, the Maximum Recorded Impact classification may be increased to a higher category. A full justification for any change to the Maximum Recorded Impact category should be provided in the assessment documentation.

The following rules govern changes to the Maximum Recorded Impact category:

A. If the original classification is found to have been erroneous, the taxon may be transferred to the appropriate classification without delay. In this case, the taxon should be re-evaluated against all the criteria to clarify its status.

B. Changes to the Maximum Recorded Impact category from **NE**, **NA**, or **DD**, should be made without delay, if the change is a result of the taxon being evaluated for the first time, becoming invasive for the first time, or due to sufficient information becoming available to categorise the taxon into one of the impact categories for the first time.

C. The reason for a transfer between categories must be documented as one of the following:

i. *Genuine.* The change in category is the result of a genuine status change that has taken place since the previous assessment, due to the species being recorded as alien for the first time, or because of a real increase in impact of the species where it is alien. Only changes from **NA** into one of the alien categories (**DD**, **MC**, **MN**, **MO**, **MR**, **MV**), or from a lower to a higher impact category, can be coded as *Genuine*.

ii. *Criteria revision.* The change in category is the result of the revision of the EICAT Categories and Criteria.

iii. *New information.* The change in category is the result of better knowledge about the taxon, e.g. owing to new or newly synthesized information about the status of the taxon or its impacts, but without a genuine change in the impact level itself. That is, the information suggests that the previous categorisation was incorrect, so a new category is assigned based on this new information.

iv. *Taxonomy.* The new category is different from the previous owing to a taxonomic change adopted during the period since the previous assessment. Such changes include: newly split (the taxon is newly elevated to the species level), newly described (the taxon is newly described as a species), newly lumped (the taxon is recognized following lumping of two previously recognized taxa) and no longer valid/recognized (either the taxon is no longer valid e.g. because it is now considered to be a hybrid or variant, form or subspecies of another species, or the previously recognized taxon differs from a currently recognized one as a result of a split or lump).

v. *Mistake.* The previous category was applied in error because the assessor(s) misunderstood the EICAT Categories and Criteria.

vi. *Incorrect data*. The previous category was applied in error because incorrect data were used (e.g. the data referred to a different taxon).

vii. *Other.* The change in category is the result of other reasons not easily covered by the above, and/or requires further explanation.

4.1.2.2 Current Impact

The Current Impact category is more flexible, and should as far as possible reflect the current magnitude of impacts caused by alien taxa. We would expect some taxa to move between categories in successive assessments, as invasion proceeds, conditions change or as management reduces the impacts of alien taxa. Some taxa may even move from an alien impact category to **NA** if all of their alien populations are eradicated. Justification of changes to the Current Impact category in successive assessments should be provided in the supporting documentation. The most recent information on the impacts of many taxa may not be especially current, such that the first assessment of current impact may result in a classification based on data that would not normally be considered contemporary (and may in some cases even be termed historical). Subsequent assessments would not alter a species' classification if newer information were not available.

The following rules govern changes to the Current Impact category:

A. If the original classification is found to have been erroneous, the taxon may be transferred to the appropriate category without delay. However, in this case, the taxon should be re-assessed against all the criteria to clarify its status.

B. A taxon may be moved from a category of higher impact to a category of lower impact if the criteria of the higher category are no longer being met for any of the impact mechanisms. The taxon should be reassessed against each mechanism and criteria to determine the correct current impact classification. Downgrading the current classification at a global level will require evidence that the change has occurred at the site(s) where the worst impacts were previously recorded.

C. A taxon may be moved from a category of lower impact to a category of higher impact if there is evidence to suggest the criteria for a higher impact category are being met for at least one impact mechanism.

D. The reason for a transfer between categories must be documented as one of the following:

i. *Genuine (recent).* The change in category is the result of a genuine status change that has taken place since the previous assessment. For example, the change is due to a newly formed alien population or a recent change of impact of pre-existing alien populations i.e. as invasion progresses temporally and spatially, or as management actions are implemented and act to reduce the impacts of alien taxa. Genuine changes can go in either direction.

ii. *Genuine (since first assessment).* This applies to taxa assessed at least three times, and is used to assign genuine category changes to the appropriate time period. The change in category is the result of a genuine status change that took place prior to the last assessment, but since the first assessment and that has only just been detected owing to new information or new documentation. If this new information had been available earlier, the new category would have been assigned during the previous assessment(s). When this code is used, the appropriate time period (between previous assessments) in which the status change occurred needs to be indicated.

iii. *Criteria revision.* The change in category is the result of the revision of the EICAT Categories and Criteria.

iv. *New information.* The change in category is the result of better knowledge about the taxon, e.g. owing to new or newly synthesized information about the status of the taxon or its impacts, but without a genuine change in the impact level itself i.e. the information suggests that the previous categorisation was incorrect, so a new category is assigned based on this new information.

v. *Taxonomy.* The new category is different from the previous owing to a taxonomic change adopted during the period since the previous assessment. Such changes include: newly split (the taxon is newly elevated to the species level), newly described (the taxon is newly described as a species), newly lumped (the taxon is recognized following lumping of two previously recognized taxa) and no longer valid/recognized (either the taxon is no longer valid e.g. because it is now considered to be a hybrid or variant, form or subspecies of another species, or the previously recognized taxon differs from a currently recognized one as a result of a split or lump).

vi. *Mistake.* The previous category was applied in error because the assessor(s) misunderstood the EICAT Categories and Criteria.

vii. *Incorrect data*. The previous category was applied in error because incorrect data were used (e.g., the data referred to a different taxon).

viii. *Other.* The change in category is the result of other reasons not easily covered by the above, and/or requires further explanation.

Determining the appropriate reason for change will require careful consideration. Category changes may result from a combination of improved knowledge and some element of genuine change in status. In such cases, “genuine” should only be assigned if the amount of genuine change (e.g., new alien population; impact affecting a new level of organisation) is sufficient on its own to cross the relevant EICAT Category threshold. Genuine and non-genuine reasons for change should never be coded at the same time. All Genuine (recent) or Genuine (since first assessment) category changes should be supported with appropriate notes to justify why the change is coded as genuine.

4.2 Impact Criteria

Twelve mechanisms have been identified by which alien taxa may cause deleterious impacts in areas to which they have been introduced (Table 1). For each mechanism, there are a number of criteria against which taxa should be evaluated, to determine the level of deleterious impact caused under that mechanism. Taxa should be evaluated against every mechanism and criterion, and the highest level of criterion met under any mechanism then determines the EICAT Category to which the taxon is assigned. These mechanisms and criteria have been developed based on those proposed by Nentwig *et al.* 2010 [20] and subsequently extended by Kumschick *et al.* 2012 [21], modified as described in Blackburn *et al*. 2014 [9]. They are aligned with those identified in the International Union for Conservation of Nature (IUCN) Global Invasive Species Database ([GISD]; http://www.issg.org/database/welcome/), and are numbered to be consistent with the numbering of impacts in the classification of impact mechanisms in the GISD.

The mechanisms are:

(1) **Competition** – the alien taxon competes with native taxa for resources (e.g. food, water, space), leading to deleterious impact on native taxa.

(2) **Predation** – the alien taxon predates on native taxa, either directly or indirectly (e.g. via mesopredator release), leading to deleterious impact on native taxa.

(3) **Hybridisation** – the alien taxon hybridises with native taxa, leading to deleterious impact on native taxa.

(4) **Transmission of disease** – the alien taxon transmits diseases to native taxa, leading to deleterious impact on native taxa.

(5) **Parasitism** – the alien taxon parasitizes native taxa, leading directly or indirectly (e.g. through apparent competition) to deleterious impact on native taxa.

(6) **Poisoning/toxicity** – the alien taxon is toxic, or allergenic by ingestion, inhalation or contact to wildlife, or allelopathic to plants, leading to deleterious impact on native taxa.

(7) **Bio-fouling** – the accumulation of individuals of the alien taxon on wetted surfaces leads to deleterious impact on native taxa.

(8) **Grazing/herbivory/browsing** – grazing, herbivory or browsing by the alien taxon leads to deleterious impact on native plant species.

(9), (10) & (11) **Chemical, physical or structural impact on ecosystem** – the alien taxon causes changes to either: the chemical, physical, and/or structural biotope characteristics of the native environment; nutrient and/or water cycling; disturbance regimes; or natural succession, leading to deleterious impact on native taxa.

(12) **Interaction with other alien species** – The alien taxon interacts with other alien taxa, (e.g., through pollination, seed dispersal, habitat modification), facilitating deleterious impact on native species. These interactions may be included under other impact mechanisms (e.g., predation, apparent competition) but would not have resulted in the particular level of impact without an interaction with other alien species

Taxa should be assessed for their impact under all the mechanisms for which data are available, and classified on the basis of evidence of their most severe impacts under any of the impact mechanisms. However, to list a particular taxon in any of the categories of impact (**MC**, **MN**, **MO**, **MR**, **MV**), evidence of impact only needs to be provided for one of the twelve mechanisms. The criteria for classification due to impacts caused by each mechanism are described in Table 1. Impacts which do not fit any of the mechanisms can still be classified, based on the general rules given in the top row of Table 1.

Table 1. Impact criteria for assigning alien taxa to different categories in the classification scheme

These categories are for taxa that have been evaluated, have alien populations (i.e., are known to have been introduced outside their native range), and for which there is adequate data to allow classification (see Figure 1). Classification follows the general principle outlined in the first row. However, the different mechanisms through which an alien taxon can cause impacts are outlined, in order to help assessors to look at the different aspects and to identify potential research gaps.

	Massive (MV)	**Major (MR)**	**Moderate (MO)**	**Minor (MN)**	**Minimal Concern (MC)**
Categories should adhere to the following general meaning	***Causes at least local extinction of native species , and irreversible changes in community composition; even if the alien taxon is removed the system does not recover its original state***	***Causes changes in community composition, which are reversible if the alien taxon is removed***	***Causes population declines in native species, but no changes in community composition***	***Causes reductions in individual fitness, but no declines in native population sizes.***	***No effect on fitness of individuals of native species***

Mechanisms					
(1) Competition	Competition resulting in replacement or local extinction of one or several native species; changes in community composition are irreversible	Competition resulting in local or population extinction of at least one native species, leading to changes in community composition, but changes are reversible when the alien taxon is removed	Competition resulting in a decline of population size of at least one native species, but no changes in community composition	Competition affects fitness (e.g., growth, reproduction, defence, immunocompetence) of native individuals without decline of their populations	Negligible level of competition with native species; reduction of fitness of native individuals is not detectable
(2) Predation	Predators directly or indirectly (e.g., via mesopredator release) resulting in replacement or local extinction of one or several native species (i.e., species vanish from communities at sites where they occurred before the alien arrived); changes in community composition are irreversible	Predators directly or indirectly (e.g., via mesopredator release) resulting in local or population extinction of at least one native species, leading to changes in community composition, but changes are reversible when the alien taxon is removed	Predators directly or indirectly (e.g., via mesopredator release) resulting in a decline of population size of at least one native species but no changes in community composition	Predators directly or indirectly (e.g., via mesopredator release) affecting fitness (e.g., growth, reproduction) of native individuals without decline of their populations	Negligible level of predation on native species
(3) Hybridisation	Hybridisation between the alien taxon and native species is common in the wild; hybrids are fully vigorous and fertile; pure native species cannot be recovered by removing the alien, resulting in replacement or local extinction of native species by introgressive hybridisation (genomic extinction)	Hybridisation between the alien taxon and native species is common in the wild; F1 hybrids are vigorous and fertile, however offspring of F1 hybrids are weak and sterile (hybrid breakdown), thus limited gene flow between alien and natives; individuals of the alien taxon and hybrids discernible from pure natives, pure native populations can be recovered by removing the alien and hybrids.	Hybridisation between the alien taxon and native species is regularly observed in the wild; hybrids are vigorous, but sterile (reduced hybrid fertility),limited gene flow between alien and natives, local decline of populations of pure native species, but pure native species persists	Hybridisation between the alien taxon and native species is observed in the wild, but rare; hybrids are weak and never reach maturity (reduced hybrid viability), no decline of pure native populations	No hybridisation between the alien taxon and native species observed in the wild (prezygotic barriers), hybridisation with a native species might be possible in captivity
(4) Transmission of diseases to native species	Transmission of diseases to native species resulting in replacement or local extinction of native species (i.e., species vanish from communities at sites where they occurred before the alien arrived); changes in community composition are irreversible	Transmission of diseases to native species resulting in local or population extinction of at least one native species, leading to changes in community composition, but changes are reversible when the alien taxon is removed	Transmission of diseases to native species resulting in a decline of population size of at least one native species, but no changes in community composition	Transmission of diseases to native species affects fitness (e.g., growth, reproduction, defence, immunocompetence) of native individuals without decline of their populations	The alien taxon is not a host of diseases transmissible to native species or very low level of transmission of diseases to native species; reduction of fitness of native individuals is not detectable
(5) Parasitism	Parasites or pathogens directly	Parasites or pathogens directly	Parasites or pathogens directly	Parasites or pathogens directly or	Negligible level of parasitism or

	or indirectly (e.g., apparent competition) resulting in replacement or local extinction of one or several native species (i.e., species vanish from communities at sites where they occurred before the alien arrived); changes in community composition are irreversible	or indirectly (e.g., apparent competition) resulting in local or population extinction of at least one native species, leading to changes in community composition, but changes are reversible when the alien taxon is removed	or indirectly (e.g., apparent competition) resulting in a decline of population size of at least one native species but no changes in community composition	indirectly (e.g., apparent competition) affecting fitness (e.g., growth, reproduction, defence, immunocompetence) of native individuals without decline of their populations	disease incidence (pathogens) on native species, reduction of fitness of native individuals is not detectable
(6) Poisoning/ toxicity	The alien taxon is toxic/allergenic by ingestion, inhalation, or contact to wildlife or allelopathic to plants, resulting in replacement or local extinction of native species; changes in community composition are irreversible	The alien taxon is toxic/allergenic by ingestion, inhalation, or contact to wildlife or allelopathic to plants, resulting in local or population extinction of at least one native species (i.e., species vanish from communities at sites where they occurred before the alien arrived), leading to changes in community composition, but changes are reversible when the alien taxon is removed	The alien taxon is toxic/allergenic by ingestion, inhalation, or contact to wildlife or allelopathic to plants, resulting in a decline of population size of at least one native species, but no changes in community composition (native species richness)	The alien taxon is toxic/allergenic by ingestion, inhalation, or contact to wildlife or allelopathic to plants, affects fitness (e.g., growth, reproduction, defence, immunocompetence) of native individuals without decline of their populations	The alien taxon is not toxic/allergenic/ allelopathic, or if it is, the level is very low, reduction of fitness of native individuals is not detectable
(7) Bio-fouling	Bio-fouling resulting in replacement or local extinction of one or several native species (i.e., species vanish from communities at sites where they occurred before the alien arrived); changes in community composition are irreversible	Bio-fouling resulting in local or population extinction of at least one native species, leading to changes in community composition, but changes are reversible when the alien taxon is removed	Bio-fouling resulting in a decline of population size of at least one native species, but no changes in community composition	Bio-fouling affects fitness (e.g., growth, reproduction, defence, immunocompetence) of native individuals without decline of their populations	Negligible level of bio-fouling on native species; reduction of fitness of native individuals is not detectable
(8) Grazing/ herbivory/ browsing	Herbivory resulting in replacement or local extinction of one or several native plant species (i.e., species vanish from communities at sites where they occurred before the alien arrived); changes in community composition are irreversible	Herbivory resulting in local or population extinction of at least one native plant species, leading to changes in community composition, but changes are reversible when the alien taxon is removed	Herbivory resulting in a decline of population size of at least one native species, but no changes in community composition	Herbivory affects fitness (e.g., growth, reproduction, defence, immunocompetence) of individual native plants without decline of their populations	Negligible level of herbivory on native plant species, reduction of fitness on native plants is not detectable
(9), (10) & (11) Chemical, physical, or structural impact on	Many changes in chemical, physical, and/or structural biotope characteristics; or	Changes in chemical, physical, and/or structural biotope characteristics; or changes in nutrient	Changes in chemical, physical, and/or structural biotope characteristics; or changes in nutrient	Changes in chemical, physical, and/or structural biotope characteristics; or changes in nutrient	No changes in chemical, physical, and/or structural biotope characteristics; or

ecosystems	changes in nutrient and water cycling; or disturbance regimes; or changes in natural succession, resulting in replacement or local extinction of native species (i.e., species vanish from communities at sites where they occurred before the alien arrived); changes (abiotic and biotic) are irreversible	cycling; or disturbance regimes; or changes in natural succession, resulting in local extinction of at least one native species, leading to changes in community composition, but changes are reversible when the alien taxon is removed	cycling; or disturbance regimes; or changes in natural succession, resulting in a decline of population size of at least one native species, but no changes in community composition	cycling; or disturbance regimes; or changes in natural succession detectable, affecting fitness (e.g., growth, reproduction, defence, immunocompetence) of native individuals without decline of their populations	changes in nutrient cycling; or disturbance regimes; or changes in natural succession detectable, or changes are small with no reduction of fitness of native individuals detectable
(12) Interaction with other alien species	Interaction of an alien taxon with other aliens (e.g., pollination, seed dispersal, habitat modification) facilitates replacement or local extinction of one or several native species (i.e., species vanish from communities at sites where they occurred before the alien arrived), and produces irreversible changes in community composition that would not have occurred in the absence of the species. These interactions may be included under other impact categories (e.g., predation, apparent competition) but would not have resulted in the particular level of impact without an interaction with other alien taxa.	Interaction of an alien taxon with other aliens (e.g., pollination, seed dispersal, habitat modification) facilitates local or population extinction of at least one native species, and produces changes in community composition that are reversible but would not have occurred in the absence of the species. These interactions may be included under other impact categories (e.g., predation, apparent competition) but would not have resulted in the particular level of impact without an interaction with other alien taxa.	Interaction of an alien taxon with other aliens (e.g., pollination, seed dispersal, habitat modification) facilitates a decline of population size of at least one native species, but no changes in community composition; changes would not have occurred in the absence of the species. These interactions may be included under other impact categories (e.g., predation, apparent competition) but would not have resulted in the particular level of impact without an interaction with other alien taxa.	Interaction of an alien taxon with other aliens (e.g., pollination, seed dispersal) affects fitness (e.g., growth, reproduction, defence, immunocompetence) of native species' individuals without decline of their populations; changes would not have occurred in the absence of the species. These interactions may be included under other impact categories (e.g., predation, apparent competition) but would not have resulted in the particular level of impact without an interaction with other alien taxa.	Interaction of an alien taxon with other aliens (e.g., pollination, seed dispersal) but with minimal effects on native species; reduction of fitness of native individuals is not detectable

4.3 Taxonomic and geographic scope of the classification process

4.3.1 Taxonomic scale

The EICAT process may be applied to species, subspecies or (for plants) varieties or cultivars introduced outside their natural past or present distribution (http://www.cbd.int/decision/cop/?id=7197) or to newly occurring taxa arising from breeding or hybridization. In these guidelines, the terms 'taxon' and 'taxa' are used to represent these taxonomic levels. For any EICAT assessments, the taxonomic unit used (species, subspecies, lower taxon) should be specified in the supporting documentation.

We note that invasion, and by extension impact, is a characteristic of a population, rather than a species: not all populations of a given taxon necessarily become invasive. It follows that the EICAT classification of a taxon will generally reflect impact recorded from one or a small number of populations, and hence that population level impacts translate into taxon-level assessments. This reflects the precautionary principle[2] for alien impacts, as impact caused by one population suggests the potential for other populations of the same taxon to cause similar impact elsewhere if they were transported outside of their natural boundaries. At the same time, we would also emphasise that while the EICAT classification provides important insights into the threat posed to new regions, it is based only on impacts that have actually been observed. Potential impact is an estimate of the magnitude of impact that would result if an invasion occurred, which might incorporate information from the native range, trait analyses, and mechanistic models. Potential impact is an essential part of risk assessment, but is not currently part of the EICAT scheme. EICAT classification should not be used alone as a proxy for potential impact, nor provide sufficient information for a risk assessment. Similarly, species with no alien populations can only be categorised as **NA**.

4.3.2 Geographic scale

The EICAT process can be applied to impacts assessed at a range of spatial scales, from global to national or regional. As most taxa that are alien and have impacts somewhere have not been introduced to many of the locations where they could potentially thrive and have impacts, the vast majority of assessments will use 'focal region' data to generate a global level species assessment. Again, this reflects the precautionary principle for alien impacts, which is important as there is evidence that many alien taxa can have strong impacts in at least part of their invaded range, if distributed sufficiently widely. However, impact listings are likely to be context dependent: an alien impact that is observed in one area of the introduced range may not occur elsewhere, or may not be as important elsewhere. Therefore national or regional level assessments, which only take into account impacts which have occurred within a particular country or region, may differ markedly from global level assessments which are based on the highest level of impact recorded anywhere in the alien range of the taxon being assessed. Non-global assessments should therefore be clearly identified as such, and carried out and submitted separately to global level assessments. Non-global assessments may still be based on data from focal regions outside the particular country or region of interest, however, and so the area(s) from which data on impacts are considered for these assessments should be clearly stated.

[2]Given the unpredictability of the pathways and impacts on biological diversity of invasive alien species, efforts to identify and prevent unintentional introductions as well as decisions concerning intentional introductions should be based on the precautionary approach. The precautionary approach is that set forth in principle 15 of the 1992 Rio Declaration on Environment and Development and in the preamble of the Convention on Biological Diversity.

The spatial scale(s) at which impacts are measured can affect interpretation of their severity. Studies at very restricted spatial scales (i.e. patches of 10s or 100s of square metres) might overestimate impacts if extrapolated to larger scales, while studies at extensive spatial scales (i.e. regional or national) might underestimate them. In other words, there may be a mismatch between the scale of study and the scale of the impact. For example, an alien taxon might be shown in a field experiment to exclude natives from areas the size of experimental plots, and perhaps even to extirpate natives from entire habitat patches, but at larger spatial scales they may not have a significant effect on community diversity (e.g. because of the influence of spatial dynamics, refugia, or rescue effects). In this case, it is likely that populations of some natives would have declined (e.g. competitors or food species) in the habitats in which the alien taxon occurs, without resulting in local extinctions. However, impacts demonstrated even at very small spatial scales, may highlight cause for greater concern in future, and thus small-scale studies may provide useful evidence of impacts for informing EICAT assessments.

Nevertheless, the impacts of aliens should ideally be measured at an appropriate spatial scale, taking into account the typical spatial scale at which the original native communities can be characterized. Assessments based on evidence generated at spatial scales that are very different to the spatial scales over which native communities can be characterized are likely to be subject to greater uncertainty, due to the uncertainties involved in extrapolating or down-scaling data to scales relevant to native communities. In practise it is very difficult to generate a universally applicable definition to describe 'the typical spatial scale at which native communities can be characterised', as this will depend on the particular set of species and environmental factors composing the community in question. A qualitative evaluation of the suitability of the spatial scale over which supporting data on impacts are recorded is therefore used, in part, to inform confidence ratings of EICAT assessments. Supporting documentation for all EICAT assessments should include a rationale for the confidence rating of the assessment, which should provide a detailed description of the spatial scale at which impacts have been measured, and how this relates to the spatial scale of native communities. The process for assessing confidence in EICAT classifications is described below in section 5.3.

4.3.3 Managed versus unmanaged alien populations

It is likely that some alien taxa will be the subject of management plans to eradicate or control their populations in invaded areas, or to prevent further spread. This is particularly likely for alien taxa with highly deleterious impacts (**MV** or **MR**; Box 1), and/or that are readily amenable to control, and the likely result is that the current highest level of impact caused by the taxon (Current Impact) will be below the highest level of impact ever recorded for the taxon (Maximum Recorded Impact). The EICAT process may be used to assess the success of management actions by comparing these two classifications.

For some alien taxa, parts of the invaded range may be subject to management actions whereas other parts may not. In these cases, the EICAT process should be carried out as normal, with Maximum Recorded Impact classified based on the highest ever level of impact recorded, and Current Impact classified based on the highest current level of impact, anywhere in the alien range of the taxon being assessed. However, the supporting documentation for the assessment should include a detailed description of where impacts were recorded and whether management was in place in these areas. For all taxa, the supporting documentation should include a detailed description of the management actions in place, including the aim, type of management (see section 6.3.3: Management Action Classification) and timescale of management actions.

4.3.4 Use of data from the native range

Data and observations from the native range are often important components of risk assessments, but such data should not be used in estimating Current or Maximum Recorded Impacts. The EICAT scheme is purely about impact in the alien range of a species. Where there is uncertainty as to whether a study is in the native range or not, this should be recorded in the essential documentation.

5. Dealing with Uncertainty

There are likely to be many cases where uncertainty exists about the correct classification of a taxon in terms of the magnitude of its impacts, even for taxa for which the available data are considered adequate for an assessment to be made. Consequently, an estimate of the degree of uncertainty should be attached to all classifications, so that the degree of confidence in every classification is explicitly made clear. Only epistemic or reducible uncertainty (i.e., uncertainty due to data quality) is of importance. Uncertainty related to variation in impacts in space or time (stochasticity or irreducible uncertainty) is not relevant here because only the highest impact reported is considered for assessment purposes.

A number of factors will affect the confidence in an assessment, including the availability, reliability and type of data used as evidence of impacts; the spatial scale over which data were collected; the ease of interpretation of the available data; and whether or not all available data are in agreement with respect to the magnitude of recorded impacts (although variation in impacts across space and time is to be expected).

5.1 Data availability

As the spatial extent and timeline of invasions varies widely between taxa, so too will the availability and quality of data on the impacts of invasions. For taxa with well-established and widespread alien populations, there is likely to have been sufficient opportunity to gather data pertaining to the impacts of the alien taxa on the native biota, so it is more likely that adequate data will be available to categorise such alien taxa. However for taxa with short alien population residence times, or invasions restricted to small areas, data evidencing impacts on native biota may be limited, or restricted to impacts in one particular area. Irrespective of the spatial extent of the invasion, 'focal region' data may be used to generate a global-level species assessment. In some cases, there may be insufficient evidence to categorise a taxon with respect to its impacts, or the residence time may be too short for impacts to have become apparent. In these cases, information about impacts may be inferred from indirect observations, such as circumstantial evidence of impacts, or outcomes from mathematical models. However, inferred data are likely to provide a much lower level of confidence in the assessment. Taxa assigned to one of the impact categories based on inferred data should be re-assessed as and when better observational data become available, to improve the confidence rating of the assessment. If there is inadequate information to classify a taxon with respect to its impact, the taxon should be listed as Data Deficient (**DD**).

5.1.1 Data types

A number of different types of data may be used as evidence of the impacts of alien taxa on the native environment in EICAT assessments, with different data types associated with different levels of confidence in the resultant classification. Data are broadly classified as either Observed or Inferred. These terms are defined as:

Observed: Information that is directly based on well-documented observations of the impacts of an alien population upon native biotic or abiotic environments. In this context, the term 'observed data' incorporates empirical observations, designed observational studies (natural experiments) and manipulative experiments. Examples include comparison of sites before and after invasions [e.g. 22]; comparison of reference plots in invaded and uninvaded areas [e.g. 23]; and field removal experiments [e.g. 24].

Inferred: Information that is not based on well-documented observations of the impacts of an alien population, such as the outcomes of mathematical models that may include assumptions about relationships between an observed variable (e.g., an index of abundance) to the variable of interest (e.g. the decline in a native population). Any assumptions should be stated and justified in the documentation. Examples include circumstantial evidence, the use of predictive mechanistic models, or the use of invasion history information (i.e. information about previous invasions in other areas) to estimate impact in new areas [e.g. 25].

5.2 Spatial Scale

The spatial scale(s) over which impact data are recorded will affect confidence in the assessment. Impacts should ideally be measured at an appropriate spatial scale, taking into account the typical spatial scale at which the original native communities can be characterized. Assessments based on evidence generated at spatial scales that are very different to the spatial scales over which native communities can be characterized are likely to be subject to greater uncertainty, due to the uncertainties involved in extrapolating or down-scaling data to scales relevant to native communities. However, in practise it is very difficult to generate a universally applicable definition to describe 'the typical spatial scale at which native communities can be characterised', as this will depend on the particular set of species making up the community, and their location. For example, a fish community in a lake may have a clearly defined spatial scale, determined by the size of the lake, whereas it may be much harder to delineate the spatial scale of particular communities within a rainforest ecosystem.

Assessors must therefore judge the suitability of the spatial scale over which evidence of impacts is recorded, for each EICAT assessment. This is used to help determine the confidence rating for the assessment (see section 5.3). Assessors should decide which of the following statements is most accurate for the evidence supporting an assessment:

i) Impacts are recorded at the typical spatial scale over which original native communities can be characterized.
ii) Impacts are recorded at a spatial scale which may not be relevant to the scale over which original native communities can be characterized, but extrapolation or downscaling of the data to relevant scales is considered reliable or to embrace little uncertainty.
iii) Impacts are recorded at a spatial scale which is unlikely to be relevant to the scale over which original native communities can be characterized, and extrapolation or downscaling of the data to relevant scales is considered unreliable or to embrace significant uncertainties.

A full justification for this evaluation should be provided in the rationale for the confidence rating in the supporting documentation, along with detail of the spatial scale at which impacts have been measured, and how this relates to the spatial scale over which native communities can be characterised.

5.3 Assigning a confidence score

For each alien taxon that is assessed and for which adequate data exist to allow for classification, the assessor should place it in the most likely of the five impact categories (**MC**, **MN**, **MO**, **MR**, **MV**) and assign a level of confidence to this placement according to the availability and reliability of evidence, the type of data used to make the assessment, the spatial scale over which data were recorded, and whether or not the evidence is contradictory. Confidence is categorised into three levels; **high**, **medium** and **low**. High confidence should be assigned when there is relevant direct observational evidence to support the assessment; the data are reliable and of good quality; impacts are recorded at the typical spatial scale at which original native communities can be characterized; and all evidence points in the same direction. Medium confidence should be assigned when there is some direct observational evidence to support the assessment, but some of the data are inferred (e.g. impact estimated from mathematical models); impacts are recorded at a spatial scale which may not be relevant to the scale over which original native communities can be characterized but extrapolation or downscaling of the data to relevant scales is considered reliable, or to embrace little uncertainty; and/or there is some degree of ambiguity in the direction or magnitude of the impact. Low confidence is defined as no direct observational evidence to support the assessment, for example only data from other species have been used as supporting evidence; or data are of low quality or strongly ambiguous; or impacts are recorded at a spatial scale which is unlikely to be relevant to the scale at which original native communities can be characterized and extrapolation or downscaling of the data to relevant scales is considered unreliable or to embrace significant uncertainties. More detailed descriptions of confidence levels are given in Table 2. Confidence levels may be translated into arbitrary probabilities that the assigned category is the correct one. High confidence means that the assessor feels they have approximately 90% chance of the given score being correct. Medium confidence is defined as 65-75% chance of the assessor score being correct and Low confidence only 35% chance of being correct. Further information about the probability distribution of correct classification is given in Appendix 1.

Table 2. Guidance regarding the use of the confidence rating (modified from the EPPO pest risk assessment decision support scheme (Alan MacLeod 09/03/2011; revised 28/04/2011; copied from CAPRA, version 2.74; *2*)).

Confidence level	**Examples**
High (approx. 90% chance of assessment being correct)	There is direct relevant observational evidence to support the assessment; *and* Impacts are recorded at the typical spatial scale over which original native communities can be characterized; *and* There are reliable/good quality data sources on impacts of the taxa; *and* The interpretation of data/information is straightforward; *and* Data/information are not controversial or contradictory.
Medium (approx. 65-75% chance of assessment being correct)	There is some direct observational evidence to support the assessment, but some information is inferred; *and/or* Impacts are recorded at a spatial scale which may not be relevant to the scale over which original native communities can be characterized, but extrapolation or downscaling of the data to relevant scales is considered reliable, or to embrace little uncertainty; *and/or* The interpretation of the data is to some extent ambiguous or contradictory.
Low (approx. 35% chance of assessment	There is no direct observational evidence to support the assessment, e.g. only inferred data have been used as supporting evidence; *and/or* Impacts are recorded at a spatial scale which is unlikely to be relevant to the scale over which original native communities can be characterized, and extrapolation or downscaling of

being correct)	the data to relevant scales is considered unreliable or to embrace significant uncertainties. *and/or* Evidence is poor and difficult to interpret, e.g. because it is strongly ambiguous. *and/or* The information sources are considered to be of low quality or contain information that is unreliable.

6. Documentation

All EICAT assessments should be supported by documentation which serves to justify the assessment and to provide relevant information about the taxon and its impacts, which can be used, for example, by regulatory bodies and management practitioners to develop risk assessments and prioritise management actions. There is a minimum level of supporting information that is essential for any assessment, and further recommended documentation that would be useful if the information is available. The more relevant supporting information that is attached to an assessment, the more useful the assessment will be. The **Essential** and **Recommended** documentation for EICAT assessments are outlined below.

6.1 Essential Documentation

The supporting information detailed below must accompany all EICAT assessments before they can be accepted for publication.

6.1.1 Taxonomy

- Scientific name (genus name and species epithet) including authority details. Infra-specific details must also be provided if relevant.
- Higher taxonomy details for Kingdom, Phylum, Class, Order and Family.
- Common names should be provided, in English, French and Spanish if available.
- Taxonomic notes should be included when there are particular problems or issues. Examples include taxa that have undergone recent taxonomic revision or where there are any taxonomic doubts or debates about the validity or identity of the taxon. Taxonomic notes should include synonyms for taxa with commonly used alternative names.

6.1.2 Assessment Information – basis for classification

- The Maximum Recorded Impact, and Current Impact classifications and the criterion (or criteria) for which each classification is met (only the criteria which are met for the highest category to which the taxa can be assigned should be specified). The confidence rating for each classification should be stated. The version of the EICAT Categories and Criteria used to make the assessment should be indicated.

- A rationale for the classifications. This should include a detailed description of impacts, where and when they were recorded, the data used as evidence, reasons for any change in classification since previous assessment, and should summarise any numerical data and parameter estimates that underpin the assessment. Uncertainty as to whether a study is in the native range or not should be recorded.
- A rationale for the confidence ratings relating to the type, quality, spatial scale and interpretation of data.
- Date of the assessment – the final date when all Assessors involved in the assessment agreed on the appropriate EICAT category for the taxon.
- The names and email addresses (ideally valid for the foreseeable future) of the people or organisations responsible for making the assessment and compiling the supporting information.
- The names and email addresses of the people who have peer reviewed and accepted the assessment and the supporting documentation.
- The names of any other individuals that have provided data, information, comments or helped in some way with the assessment, but who are not responsible for the EICAT assessment itself and/or were not involved in the overall compilation of the assessment.

6.1.3 Alien Range

- A detailed description of the alien range of the taxon, including dates of introductions where this information is known.
- A list of countries of occurrence and sub-country units for large countries and islands far from mainland countries, where the taxon has been introduced outside of its native range (see section 6.3.1: Distribution Information, for information about the distribution recording system).
- A list of occurrence in marine regions outside of the native range (see section 6.3.1).
- Pathways and vectors of introduction and spread where this information is known.

6.1.4 Habitat and Ecology

- A summary of the habitat and ecology of the alien taxon.
- The major biomes in which the alien taxon occurs (i.e., marine, freshwater, terrestrial).
- A list of habitat preferences of the alien taxon (see section 6.3.2: Habitat Classification Scheme, for further information).

6.1.5 Impacts and mechanisms

- A detailed description of all the impacts recorded for the alien taxon, including the mechanism and the level of criteria met for each impact. This should include a description of where and when each impact has been recorded/documented, and the native biota that are impacted. Uncertainty as to whether a study is in the native range or not should be noted. It should also be noted whether these impacts were recorded in the presence or absence of any management actions.

- Supporting evidence for each impact listed.

6.1.6 Management actions

- A list of management actions in place to manage the spread of the alien taxon, or to remove the taxon from a non-native area (see section 6.3.3: Management Action Classification for further information).
- Further detail about management actions, including the area that is being managed, and the length of time since management action began.

6.1.7 Bibliography

The list of references (published and unpublished but traceable) used for the assessment and the supporting documentation.

6.2 Recommended Documentation

Recommended supporting information is not essential for an EICAT assessment to be accepted for publication on the EICAT but is encouraged for all assessments.

6.2.1 Native Geographic Range

- Detailed description of the native distribution of the taxon.
- A GIS map of the distribution of the taxon, preferably shown as polygons (but point occurrences may also be displayed)
- A list of countries of occurrence and sub-country units for large countries and islands far from mainland countries (see section 6.3.1: Distribution Information, for information about the distribution recording system).
- A list of marine regions in which the taxon occurs (see section 6.3.1).

6.2.2 Alien Range

- A GIS map of the alien distribution, preferably shown as polygons (but point occurrences may also be displayed) should ideally be submitted.

6.2.3 Alien Populations

- A detailed description of alien populations including information on location, size, trends and spread.
- Where relevant, cultivated distribution should be identified separately from naturalized or invasive distribution.

6.2.4 *Other impacts of the alien taxon*

- Information on the socio-economic impacts of the alien taxon, including beneficial (e.g. human use) as well as deleterious impacts, if known. Note that this information should not contribute to the classification of the alien taxon.

6.2.5 *Links to images and other sources of information*

- Links to other web sites that may contain further information and images of the taxon concerned.

6.2.6 *Recommendations for future assessments*

- Observations or data required to improve confidence in the current assessment (e.g. the likelihood of spatial variation in impacts, such that classification may be improved by data from other specified regions).
- Information on the likelihood of a classification changing in the near future, with consequences for the urgency of management responses or future assessments.

6.3 Classification schemes and further information

6.3.1 *Distribution Information*

The EICAT has adopted the same distribution recording system as used in the IUCN Red List of Threatened Species. Distribution is recorded in terms of country names following the 5th edition (and subsequent web updates) of the ISO-3166-1 standard [26]. For large countries (e.g. Australia, Brazil, China, India, South Africa, the Russian Federation and the United States of America) or countries spanning diverse biogeographic regions (e.g. Colombia, Ethiopia, Pakistan), distributions within the country should also be listed, using the standard set of Basic Recording Units (BRU) provided by the International Working Group World Geographical Scheme for Recording Plant Distributions (TDWG). These Basic Recording Units (BRU) are sub-country units based on provinces or states. Unless geographically very remote from each other, islands and other territories are included with the parent country. In the case of taxa that inhabit islands significantly distant from the mainland, the island name is given in parentheses (e.g., Spain (Canary Islands)). The naming of such islands follows Brummitt [27], prepared for the TDWG.

For marine taxa, country records should be provided wherever possible. This information can be derived from a number of sources, e.g. FishBase and the many FAO publications. For some marine taxa, particularly those with ranges outside of territorial waters, distributions should also be shown as generalized ranges in terms of the FAO Fishing Areas.

6.3.2 *Habitats classification scheme*

The EICAT has adopted the same habitat nomenclature as used in the IUCN Red List of Threatened Species [10]. The habitat types listed below are standard terms used to describe the major habitat(s) in which taxa occur.

The three levels of the hierarchy are self-explanatory, as they use familiar habitat terms that take into account biogeography, latitudinal zonation, and depth in marine systems. The inland aquatic habitats are based primarily on the classification system of wetland types used by the Ramsar Convention (see Ramsar Wetland Type Classification System). Further details about applying the habitats classification scheme, including a brief description of each habitat, can be found here.

1 Forest

- 1.1 Boreal Forest
- 1.2 Subarctic Forest
- 1.3 Subantarctic Forest
- 1.4 Temperate Forest
- 1.5 Subtropical/Tropical Dry Forest
- 1.6 Subtropical/Tropical Moist Lowland Forest
- 1.7 Subtropical/Tropical Mangrove Forest Vegetation Above High Tide Level
- 1.8 Subtropical/Tropical Swamp Forest
- 1.9 Subtropical/Tropical Moist Montane Forest

2 Savanna

- 2.1 Dry Savanna
- 2.2 Moist Savanna

3 Shrubland

- 3.1 Subarctic Shrubland
- 3.2 Subantarctic Shrubland
- 3.3 Boreal Shrubland
- 3.4 Temperate Shrubland
- 3.5 Subtropical/Tropical Dry Shrubland
- 3.6 Subtropical/Tropical Moist Shrubland
- 3.7 Subtropical/Tropical High Altitude Shrubland
- 3.8 Mediterranean-type Shrubby Vegetation

4 Grassland

- 4.1 Tundra
- 4.2 Subarctic Grassland

4.3 Subantarctic Grassland

4.4 Temperate Grassland

4.5 Subtropical/Tropical Dry Lowland Grassland

4.6 Subtropical/Tropical Seasonally Wet/Flooded Lowland Grassland

4.7 Subtropical/Tropical High Altitude Grassland

5 Wetlands (inland)

5.1 Permanent Rivers, Streams, Creeks [includes waterfalls]

5.2 Seasonal/Intermittent/Irregular Rivers, Streams, Creeks

5.3 Shrub Dominated Wetlands

5.4 Bogs, Marshes, Swamps, Fens, Peatlands [generally over 8 ha]

5.5 Permanent Freshwater Lakes [over 8 ha]

5.6 Seasonal/Intermittent Freshwater Lakes [over 8 ha]

5.7 Permanent Freshwater Marshes/Pools [under 8 ha]

5.8 Seasonal/Intermittent Freshwater Marshes/Pools [under 8 ha]

5.9 Freshwater Springs and Oases

5.10 Tundra Wetlands [includes pools and temporary waters from snowmelt]

5.11 Alpine Wetlands [includes temporary waters from snowmelt]

5.12 Geothermal Wetlands

5.13 Permanent Inland Deltas

5.14 Permanent Saline, Brackish or Alkaline Lakes

5.15 Seasonal/Intermittent Saline, Brackish or Alkaline Lakes and Flats

5.16 Permanent Saline, Brackish or Alkaline Marshes/Pools

5.17 Seasonal/Intermittent Saline, Brackish or Alkaline Marshes/Pools

5.18 Karst and Other Subterranean Inland Aquatic Systems

6 Rocky Areas [e.g. inland cliffs, mountain peaks]

7 Caves and Subterranean Habitats (non-aquatic)

7.1 Caves

7.2 Other Subterranean Habitat

8 Desert

8.1 Hot

8.2 Temperate

8.3 Cold

9 Marine Neritic (Submergent Nearshore Continental Shelf or Oceanic Island)

9.1 Pelagic

9.2 Subtidal Rock and Rocky Reefs

9.3 Subtidal Loose Rock/Pebble/Gravel

9.4 Subtidal Sandy

9.5 Subtidal Sandy-Mud

9.6 Subtidal Muddy

9.7 Macroalgal/Kelp

9.8 Coral Reef

9.8.1 Outer Reef Channel

9.8.2 Back Slope

9.8.3 Foreslope (Outer Reef Slope)

9.8.4 Lagoon

9.8.5 Inter-Reef Soft Substrate

9.8.6 Inter-Reef Rubble Substrate

9.9 Seagrass (Submerged)

9.10 Estuaries

10 Marine Oceanic

10.1 Epipelagic (0–200 m)

10.2 Mesopelagic (200–1,000 m)

10.3 Bathypelagic (1,000–4,000 m)

10.4 Abyssopelagic (4,000–6,000 m)

11 Marine Deep Ocean Floor (Benthic and Demersal)

11.1 Continental Slope/Bathyl Zone (200–4,000 m)

11.1.1 Hard Substrate

11.1.2 Soft Substrate

11.2 Abyssal Plain (4,000–6,000 m)

11.3 Abyssal Mountain/Hills (4,000–6,000 m)

11.4 Hadal/Deep Sea Trench (>6,000 m)

11.5 Seamount

11.6 Deep Sea Vents (Rifts/Seeps)

12 Marine Intertidal

12.1 Rocky Shoreline

12.2 Sandy Shoreline and/or Beaches, Sand Bars, Spits, etc.

12.3 Shingle and/or Pebble Shoreline and/or Beaches

12.4 Mud Shoreline and Intertidal Mud Flats

12.5 Salt Marshes (Emergent Grasses)

12.6 Tidepools

12.7 Mangrove Submerged Roots

13 Marine Coastal/Supratidal

13.1 Sea Cliffs and Rocky Offshore Islands

13.2 Coastal Caves/Karst

13.3 Coastal Sand Dunes

13.4 Coastal Brackish/Saline Lagoons/Marine Lakes

13.5 Coastal Freshwater Lakes

14 Artificial - Terrestrial

14.1 Arable Land

14.2 Pastureland

14.3 Plantations

14.4 Rural Gardens

14.5 Urban Areas

14.6 Subtropical/Tropical Heavily Degraded Former Forest

15 Artificial - Aquatic

15.1 Water Storage Areas [over 8 ha]

15.2 Ponds [below 8 ha]

15.3 Aquaculture Ponds

15.4 Salt Exploitation Sites

15.5 Excavations (open)

15.6 Wastewater Treatment Areas

15.7 Irrigated Land [includes irrigation channels]

15.8 Seasonally Flooded Agricultural Land

15.9 Canals and Drainage Channels, Ditches

15.10 Karst and Other Subterranean Hydrological Systems [human-made]

15.11 Marine Anthropogenic Structures

15.12 Mariculture Cages

15.13 Mari/Brackish-culture Ponds

16 Introduced Vegetation

17 Other

18 Unknown

6.3.3 Management action classification

Any management actions in place to eradicate or control the alien taxon, or mitigate its impacts on native taxa, should be classified based on the scheme below, developed for the Global Invasive Species Database. Actions are broadly classified according to their ultimate aim (monitoring, prevention, control or eradication; Table 3) and then based on the methods used (Tables 4 – 6). A number of different methods are often used together, and where this is the case, all management actions in place should be listed. Detail about the area covered by the management action should also be provided so that impacts can be understood in the context of any management actions in place.

7. EICAT Process

The basic process for preparing and submitting assessments for publication on the EICAT is as follows: raw data are gathered and provided by "*Contributors*"; "*Assessors*"(from *EICAT Authorities* or external bodies) use the data and the EICAT Categories and Criteria to assess the taxon, and to document the assessment; the draft assessment is made available to the wider community of invasive species experts; once a consensus is reached on the classification, assessments are sent to external *reviewer(s)*; reviewed assessments are submitted to the *EICAT Unit* for final checks; accepted assessments are published on the Global Invasive Species Database (GISD).

Table 3. Codes, names and definitions of different management actions for alien species.

Management CATEGORY CODE	Management CATEGORY NAME	Definition
6	Monitoring	Measures taken to evaluate the distribution, the expansion and/or the density of the alien species.
1	Prevention	Measures taken to stop the species from entering an area.
2	Eradication	Actions taken to eliminate all occurrences of a species. Long term, on-going eradication projects are included in this category.
3	Control	Measures taken to reduce a species or biomass (control), to keep a species in a defined area (containment), and/or to reduce harmful effects of a species (mitigation).
4	None	
5	Unknown	

Table 4. Codes and names of management actions aiming to prevent alien species from entering an area.

Prevention Method CODE	Prevention Method NAME
1	Risk assessment
2	Legal Status (restrictions)
3	Best practises
4	Cultural methods

Table 5. Codes and names of management actions designed to control populations of alien species established in an area.

Control Method CODE	Control Method NAME
1	Physical-Mechanical (manual)
2	Chemical
3	Biological
4	Integrated methods
99	Unknown

Table 6. Codes and names of management actions aiming to eradicate populations of alien species from an area in which they are established.

Eradication Method CODE	Eradication Method NAME
1	Shooting
2	Trapping
3	Hand removal
4	Pesticides or herbicides
5	Poisoning or toxicants
6	Others (disease, fumigants, draining...)
99	Unknown

The EICAT process is coordinated by EICAT Authorities and the EICAT Unit and all assessments must be submitted to the EICAT Unit prior to being published. The roles of the different parties within the EICAT process are described in more detail below.

Contributors are usually species experts or owners of databases containing species data. They provide information specifically for use in the species account, but they are not directly involved in the actual assessment itself. Reviewers (see below) may also have contributed information for the assessment, without being directly involved in the assessment itself. Therefore a Reviewer may also be named as a Contributor.

Assessors are species experts on the alien species of concern who also have good knowledge of the EICAT Categories and Criteria. The Assessor's role in the assessment process is to use all appropriate data currently available for a taxon with regard to its environmental impacts as an alien, to assess the taxon appropriately, and to determine a confidence rating for the assessment. Assessors put together the appropriate supporting information to document the assessment. In general, Assessors are named people from EICAT Authorities, but sometimes organisations may be responsible for producing assessments based on data contributed to them.

Reviewers are people with good knowledge of the EICAT Categories and Criteria. Ideally, Reviewers should also have good knowledge of the taxon being assessed, but sometimes (e.g. through lack of available species experts) this is not possible. Reviewers may be people within EICAT Authorities who have not been involved in the assessment process for the particular taxon, or may be external. The Reviewer's role is to read the information presented in the assessment and confirm whether the information has been interpreted appropriately, the EICAT Categories have been applied correctly, and that uncertainty has been handled appropriately.

EICAT Authorities – The majority of **EICAT** Authorities will be members of the IUCN Invasive Species Specialist Group, but they may also be members of independent networks or partner organisations. **EICAT** Authorities coordinate the assessment process, and carry out the majority of assessments. They arrange independent reviewers for each assessment and check all the documentation to support the assessment is in place.

EICAT Unit – The EICAT Unit is formed from selected members of the IUCN Invasive Species Specialist Group. Current members are Tim Blackburn, Piero Genovesi, Sven Bacher, Petr Pyšek, Jonathan Jeschke, and Sabrina Kumschick. The **EICAT** Unit oversees the entire process and checks each assessment to ensure consistency. It also co-ordinates the reporting of status and trends in impacts as documented by the EICAT process, and oversees any proposals for changes or revisions to the framework and guidelines.

The steps involved in the **EICAT** process are described in more detail below, and presented schematically in Figure 3.

1) Pre-assessment

The starting point is raw data. Data and information may be held in published papers, articles, books and reports, unpublished documents and reports (including expert opinion), unpublished data, databases, GIS data, satellite imagery, etc. Prior to the assessment phase, raw data are gathered from the alien ranges of the taxa being assessed. Data must be recorded in a format compatible with the standards of the EICAT Categories and Criteria and with appropriate supporting information (see section 6: Documentation). Individuals who provide data through the pre-assessment phase are termed "Contributors".

2) Assessment

All assessments are based on data currently available for taxa, compiled in step 1. In all cases, assessments must follow the EICAT Categories and Criteria and the guidelines for applying these. Each assessment must also include appropriate supporting information, as specified in section 6: Documentation.

Assessment can be carried out by EICAT Authority members working alone, in small groups, in large groups for example in a workshop; or contributions from the whole membership through a workshop or email/internet forum. Alternatively, other experts can prepare assessments to be submitted to an EICAT Authority for review. Draft assessments will be made available to the wider community of invasive species experts for additional comment within in a defined time period, via the ISSG list server and GISD. Once a consensus is reached on the species classifications, or a majority decision in the case of no consensus being reached, they will be sent for review.

3) Review

All assessments must go through a review process before they can be accepted for publication on the EICAT. **EICAT Authorities** arrange review by at least one appropriate expert reviewer, not involved in the initial assessment process. The reviewer will check that the data used have been interpreted correctly and consistently, categories have been applied correctly, and that uncertainty has been handled appropriately. The assessments should also be checked to ensure that all essential supporting documentation and any available recommended documentation, is attached and formatted correctly.

4) Submission

After a satisfactory review, assessments are submitted to the **EICAT Unit,** who conduct consistency checks to ensure that the criteria have been applied consistently and correctly across all taxa, and that uncertainty has been handled consistently.

5) Publication

Finally, for each alien taxon, its classification under the scheme (one of the codes in Figure 1), assessment (including the rationale for the classification and supporting documentation) and the names of the assessors and reviewers will be published on the **GISD**.

7.1 Rules and regulations for committee membership

These will be added once the mechanisms for the appointment and governance of the EICAT Authorities and EICAT Unit have been developed. It is hoped that this development will take place with input from IUCN.

Pre-Assessment

Data are compiled for EICAT Assessments by contributors, including **EICAT Authority** members, expert consultants and external assessors.

Assessment

Assessments are coordinated by **EICAT Authorities** and carried out by **EICAT Authority** members, expert consultants or external assessors, either individually or in groups through workshops or email/internet forums. Draft assessments are made available to the wider community of invasive species experts for additional comment via the GISD, until a consensus is reached.

Assessment rejected by reviewer(s)

Review

EICAT Authorities arrange review by at least one appropriate expert reviewer, not involved in the initial assessment process.

Assessment accepted by reviewer(s)

Problem detected

Submission

Assessments are submitted to the **EICAT Unit** who carry out consistency checks and check criteria use, handling of uncertainty, supporting documentation, proofreading and formatting of each assessment.

Reviewed and checked assessments accepted for publication

Publication

Assessments are published on the **GISD.**

Figure 3. A schematic showing the EICAT process.

8. Bibliography

1. Pyšek, P., et al., *A global assessment of invasive plant impacts on resident species, communities and ecosystems: the interaction of impact measures, invading species' traits and environment.* Global Change Biology, 2012. **18**(5): p. 1725-1737.
2. Ricciardi, A., et al., *Progress toward understanding the ecological impacts of nonnative species.* Ecological Monographs, 2013. **83**(3): p. 263-282.
3. Brooks, M.L., et al., *Effects of invasive alien plants on fire regimes.* BioScience, 2004. **54**(7): p. 677-688.
4. Hendrix, P.F., et al., *Pandora's Box Contained Bait: The Global Problem of Introduced Earthworms*.* Annual review of ecology, evolution, and systematics, 2008. **39**: p. 593-613.
5. Suarez, A.V. and N.D. Tsutsui, *The evolutionary consequences of biological invasions.* Molecular Ecology, 2008. **17**(1): p. 351-360.
6. Kenis, M., et al., *Ecological effects of invasive alien insects*, in *Ecological Impacts of Non-Native Invertebrates and Fungi on Terrestrial Ecosystems*. 2009, Springer. p. 21-45.
7. Vilà, M., et al., *Ecological impacts of invasive alien plants: a meta‐analysis of their effects on species, communities and ecosystems.* Ecology Letters, 2011. **14**(7): p. 702-708.
8. Winter, M., et al., *Plant extinctions and introductions lead to phylogenetic and taxonomic homogenization of the European flora.* Proceedings of the National Academy of Sciences, 2009. **106**(51): p. 21721-21725.
9. Blackburn, T.M., et al., *A Unified Classification of Alien Species Based on the Magnitude of their Environmental Impacts.* PLoS biology, 2014. **12**(5): p. e1001850.
10. IUCN, *IUCN Red List of Threatened Species version 2012.14. http://www.iucnredlist.org.* 2012.
11. Richardson, D.M., P. Pyšek, and J.T. Carlton, *A compendium of essential concepts and terminology in invasion ecology.* Fifty years of invasion ecology The legacy of Charles Elton. Oxford: Wiley-Blackwell, 2011: p. 409-420.
12. Carlton, J.T., *Biological invasions and cryptogenic species.* Ecology, 1996: p. 1653-1655.
13. Kumschick, S. and W. Nentwig, *Some alien birds have as severe an impact as the most effectual alien mammals in Europe.* Biological Conservation, 2010. **143**(11): p. 2757-2762.
14. Jeschke JM, Bacher S, Blackburn TM, Dick JTA, Essl F, Evans T, Gaertner M, Hulme PE, Kühn I, Mrugała A, Pergl J, Pyšek P, Rabitsch W, Ricciardi A, Richardson DM, Sendek A, Vilà M, Winter M & Kumschick S (2014) Defining the impact of non-native species: Resolving disparity through greater clarity. Conservation Biology 28, 1188–1194.
15. Lockwood, J.L., P. Cassey, and T. Blackburn, *The role of propagule pressure in explaining species invasions.* Trends in Ecology & Evolution, 2005. **20**(5): p. 223-228.

16. Wilson, J.R., et al., *Residence time and potential range: crucial considerations in modelling plant invasions.* Diversity and Distributions, 2007. **13**(1): p. 11-22.
17. Rejmánek, M., D.M. Richardson, and P. Pyšek, *Plant invasions and invasibility of plant communities*, in *Vegetation ecology*, E. Van der Maarel and J. Franklin, Editors. 2005, Wiley-Blackwell: Oxford. p. 387-424.
18. MacDougall, A.S. and R. Turkington, *Are invasive species the drivers or passengers of change in degraded ecosystems?* Ecology, 2005. **86**(1): p. 42-55.
19. Didham, R.K., et al., *Interactive effects of habitat modification and species invasion on native species decline.* Trends in Ecology & Evolution, 2007. **22**(9): p. 489-496.
20. Nentwig, W., E. Kuehnel, and S. Bacher, *A Generic Impact‐Scoring System Applied to Alien Mammals in Europe.* Conservation Biology, 2010. **24**(1): p. 302-311.
21. Kumschick, S., et al., *A conceptual framework for prioritization of invasive alien species for management according to their impact.* NeoBiota, 2012. **15**: p. 69-100.
22. Roy, H.E., et al., *Invasive alien predator causes rapid declines of native European ladybirds.* Diversity and Distributions, 2012. **18**(7): p. 717-725.
23. Hejda, M., P. Pyšek, and V. Jarošík, *Impact of invasive plants on the species richness, diversity and composition of invaded communities.* Journal of Ecology, 2009. **97**(3): p. 393-403.
24. Monks, J.M., A. Monks, and D.R. Towns, *Correlated recovery of five lizard populations following eradication of invasive mammals.* Biological invasions, 2014. **16**(1): p. 167-175.
25. Kulhanek, S.A., A. Ricciardi, and B. Leung, *Is invasion history a useful tool for predicting the impacts of the world's worst aquatic invasive species?* Ecological Applications, 2011. **21**(1): p. 189-202.
26. ISO, *ISO-3166-1. Codes for the representation of names of countries and their subdivisions - Part 1: Country Codes. Fifth edition. ISO 3166 Maintenance Agency at DIN, Berlin.* 1997.
27. Brummitt, R.K., *World Geographic Scheme for Recording Plant Distributions. Plant Taxonomic Database Standards No. 2 edition 2. International Working Group on Taxonomic Databases for Plant Sciences (TDWG)*. 2001, Hunt Institute for Botanical Documentation: Pittsburgh.
28. Holt, J., A.W. Leach, J.D. Knight, D. Griessinger, A. MacLeod, D.J. van der Gaag, G. Schrader and J.D. Mumford, *Tools for visualizing and integrating pest risk assessment ratings and uncertainties*. EPPO Bulletin, 2012, **42**(1): 35-41.

9. Appendix 1: Distribution of uncertainty

Uncertainty in assessment classifications mean that there is some probability that a taxon should in reality be assigned to another category (most likely to a neighbouring category; Figure 1). This probability will be lowest for taxa categorised with High confidence, and highest for taxa categorised with Low confidence. It is possible to estimate the distribution of this probability in each case, by assigning it on the basis of a range of theoretical probability distributions. Table S1 presents an example of this approach. Confidence levels are translated into probabilities that the assigned category is the correct one. In this example, high confidence means that the assessor feels they have approximately 90% chance of the given score being correct. Medium confidence was defined as 65-75% chance of the assessor score being correct and low confidence only 35% chance of being correct. The remaining probability has been assigned to the other categories according to a beta probability density function [28]. The Beta distribution is a continuous distribution on the range [0, 1]. It is defined by two positive parameters, α, β, that control the shape of the distribution. The range [0, 1] was discretized by dividing it into 5 equally-sized intervals, representing the 5 impact categories. We calculated the values of the beta probability density function at the mid-point of each interval, with parameters chosen such that the assigned category had the highest probability and the variance in confidence increased from High to Medium to Low, taking approximate values of 0.007, 0.011, and 0.038, respectively. Values of the beta distribution were standardized such that the 5 values sum up to 1. The table shows that a classification of **MV** with High confidence still has some probability of being incorrect, and that the most likely alternative classification is **MR**; likewise, a classification of **MO** with Low confidence has a relatively high probability of being incorrect, and the correct classification may be any of the other categories (albeit that neighbouring categories in Figure 1 are still the most likely alternatives). These distributions of likelihoods, together with the descriptions of uncertainties in Table 2, may serve as guidance for assessors to assign confidence levels to their assessments. A choice of predefined distributions offers a consistent way to infer a rating distribution from a single confidence rating, but we suggest that assessors examine these distributions carefully to make sure they accord with their own perception of confidence.

Table S1. Suggested distribution of likelihoods (in percent) of the impact of alien taxa being in a certain category depending on the confidence of the assessment. Probability distributions follow a beta probability density function with parameters α and β, as implemented in Excel. The histogram below the table provides a pictorial representation of the same probabilities.

Category	MV			MR			MO			MN			MC		
Confidence	High	Med	Low	High	Med	Low	High	Med	Low	High	Med	Low	High	Med	Low
Distribution of Likelihoods (%)															
MV	90	75	36	6	15	19	0	0	6	0	0	2	0	0	0
MR	10	23	34	87	66	35	5	15	26	0	1	15	0	0	9
MO	0	2	21	7	18	29	90	70	36	7	18	29	0	2	21
MN	0	0	9	0	1	15	5	15	26	87	66	35	10	23	34
MC	0	0	0	0	0	2	0	0	6	6	15	19	90	75	36
α/β	3/18	2/10	1.4/3	7.3/18	4.4/10	1.8/3	18/18	10/10	3/3	18/7.3	10/4.4	3/1.8	18/3	10/2	3/1.4